

Better Buildings Residential Network
Peer Exchange Call Series:
Money Down the Drain: The Energy-Water Nexus

November 9, 2017

Call Slides and Discussion Summary



Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Polls
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers:
 - Conrad Eustis, Director of Retail Technology Strategy, Portland General Electric
 - Jonathan Kevles, Vice President of Government Relations, Renew Financial
- Discussion
- Closing Poll and Announcements

Ground Rules:

- 1. Sales of services and commercial messages are not appropriate during Peer Exchange Calls.
- 2. Calls are a safe place for discussion; please do not attribute information to individuals on the call.





Better Buildings Residential Network

Join the Network

Member Benefits:

- Recognition in media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- Solution Center guided tours

Commitment:

 Members only need to provide one number: their organization's number of residential energy upgrades per year

Upcoming calls:

- November 16: Wicked Smart: Optimizing Diagnostics through Home Energy Monitoring
- November 30: Solar Decathlon Peer Exchange Call
- December 7: <u>DOE Toolkit Launch: A New Approach to Evaluate as You Go</u>
- December 14: <u>The Amazing Race: City Winners of the National Georgetown University</u> <u>Energy Prize (GUEP)</u>

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join





Best Practices: Portland General Electric

Conrad Eustis, Director of Retail Technology Strategy





Portland General Electric

872,000 customers, 52 cities served

Service territory population 1.9 million, 44% of state's population

4,000-square-mile service area

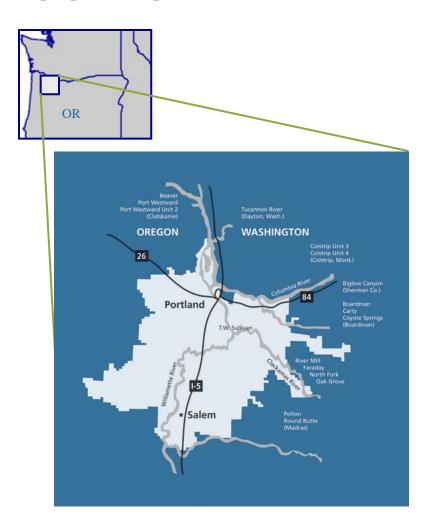
2,700 employees

Summer peak load of 3,972 MW (2017)

Winter peak load of 4,073 MW (1998)

Number #1 in US by NREL in Renewable energy sales and customers

First multi-MW Li-Ion battery-inverter system placed in operation by a US utility



Regional Pilot--Deliverables

- 300 to 600 smart water heaters.
 - •half will be heat pump water heaters
- Quantify
 - peak load mitigation
 - energy shifting
 - customer Acceptance
- Regional education
- Market transformation plan
- Business case to justify 10-year,
 \$50 mil plan
- Anticipate > 5:1 benefit/cost



National Potential

- Market:
 - 3.5 million in NW;
 - 50 million in U.S.
- Likely benefits in NW (customer adoption at 33%)
 - After ten years
 - 400 MW flex plant; worth \$400 mil.
 - 2,200 MWh storage battery; worth \$800 mil.
 - National Benefits 4 GW value ~ \$4 billion (capacity only)
- Cost (customer adoption at 33%)
 - \$15 per tank + \$1 million in engineering per manufacturer
 - Plus, \$100 per enrolled tank (comm. device and marketing)
 - Accumulated cost after ten years = \$140 million
 - Benefit/Cost ≈ 3.0 without storage benefits

Smart Water Heaters

"Smart" =

- Programmable Control
- Communication Interface
- Customer installs comm. link
- Ignores DR commands to maintain sufficient hot water

Low Cost only if:

- Standard Socket (CTA-2045)
- Accepts any communication method
- Accepts any control language
- Allows proprietary control



Currently:

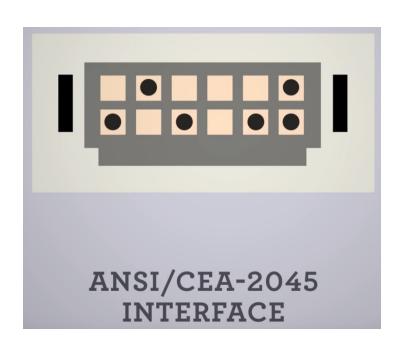
- 5 to 10% of tanks sold
- All have proprietary interfaces

Photo Credits: General Electric and A.O. Smith



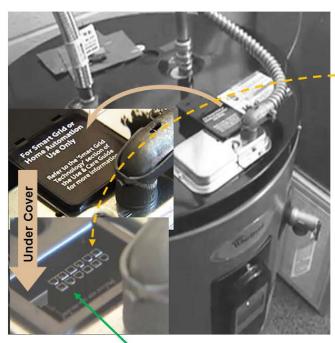
CTA-2045 to the Rescue

- CTA-2045 is the "one" and it's gaining traction
- Why a standard socket is NOT "picking a standard" but enabling them all!
- Creates simple customer experience
- Create simple provider implementation



https://www.youtube.com/watch?v=BHMssq6_R94

The Customer adds Communication



ANSI/CTA-2045 socket on tank



Example of communication device from e-Radio

Economics of with Standard

Control Method => Install Component	Control Box	Standard Socket on Tank	
Factory tank modification	none	\$15 (in volume; only \$1 for heat pump WH)	
Control box	\$100	none (uses tank controls)	
Communication device	included above	\$50 -> \$10 (in volume)	
Installation & materials	\$175 (\$25 (average) for aborted starts)	\$0 (customer-installed)	
Join program incentive	\$50 (to leave work to meet installer)	\$0	
Reserve to remove unit	\$50	\$0	
Marketing	\$M	50%*\$M	
Permit	\$15	\$0	
Total	\$390 +\$M	\$65 -> \$10 + 0.5*\$M	

Add cost of market transformation ~\$60 per tank

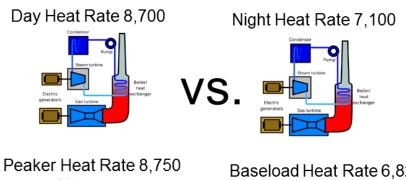
- Typical smart water heater contribution to peak 0.35 kW
- Cost per kW = \$400/kW plus program management (\$450 = \$155/0.35) ~15yr life
- Smart Water Heater can be cycled everyday for battery use case ~ 1.5 kWh twice daily
- Cost of "battery" = \$52/kWh (=\$155 / 3 kWh)

3 Ways Smart Control Saves Energy

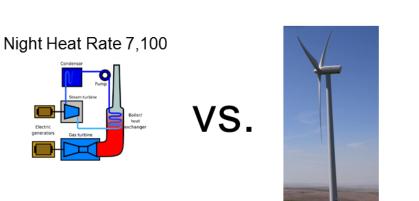
Using 3.0 kWh storage 344 days/yr

- Daily arbitrage: 220 days
 Save = 1.4 mmBtu/yr
- 2. Firming winding 2,450 hrs/yr Save = 1.3 mmBtu/yr
- Sink for excess wind or solar 20 days/yr Save = 0.3 mmBtu/yr

Total = 3.0 mmBtu/yr - Equivalent 350 kWh at meter



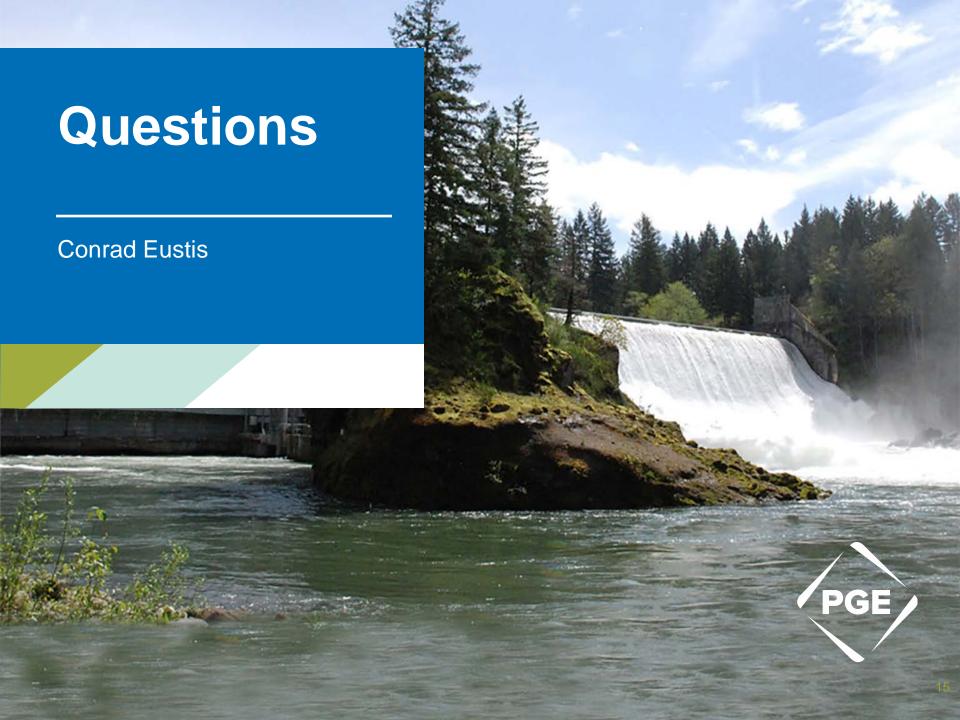




Water Heater Benefits as Flex Powerplant

- Expected benefits
 - HPWH
 - 0.18 kW load reduction;
 - 1 kWh as storage

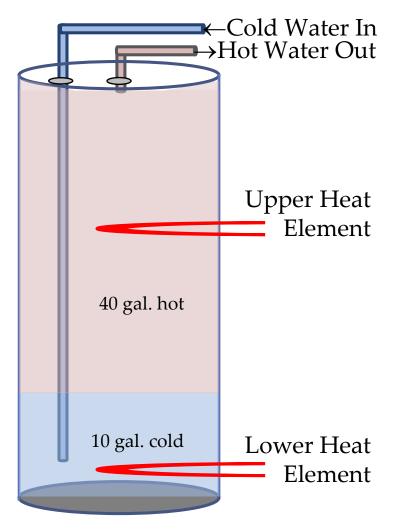
- Resistance
 - 0.35 kW load reduction;
 - 2 kWh as storage
- 24x7 ops reduces natural gas use at powerplants
 - ~ 3 million Btu/ water heater used as flex resource
- HPWH save CO₂ compare to Gas UEF 0.70
 - Basis: hot water use equivalent 3,600 kWh
 - \$\sigma\$ 1600 kWh or 175 therms
 - WECC 2018 emissions create ~ 40% reduction
 - WECC 2035 emissions create ~ 70% reduction



Increasing Benefits in HPWHs

- Mixing valve allows temperature of water heater 140 or above
 - 1 kWh could go to 3 to 4 kWh
- Liability risk for OEMs
- NEEA & BPA funding analysis for NRDC of using HPWHs to store excess solar power in CA.
 - Also looking at benefit/cost of mixing valve
- 12 million (mostly gas water heaters) in California
 - Another partner for market transformation
 - 3.5 * 12 = 42 million MWh
 - Average of 7 GW of solar excess for 6 hours = 42 million MWh
 - nice balance for current problem

How Water Heaters act like Batteries



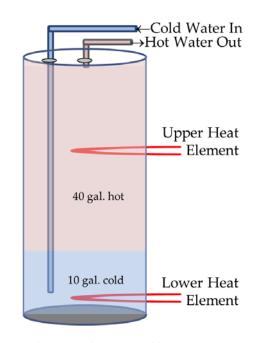
Normal Water Heater Operation

- Hot water is pushed out of the top of the tank by the pressure of cold water entering the tank at the bottom.
- Hot water naturally "floats" on top of the cold water; even after hours, the hot and cold water volumes mix very little.
- When cold is detected at the bottom of the tank the lower heating element turns on. If you use a lot of hot water in a short period, the cold water reaches the upper heating element; the upper element has priority, turns on, and heats water until the temperature set point is reached, then the bottom element continues to heat cold water at the bottom.
- When the entire tank is at the temperature set point both elements will be off.

How Water Heaters act like Batteries

Operation of Smart Water Heaters

- At times when total grid demand is highest (~7a & 7p), the utility will request the tank to turn **off** the heating elements.
- If you use hot water during this control period, cold water will accumulate in the bottom of the tank to a maximum of about 20% to 30% of tank volume.
- But if you use more than this amount of hot water, the "smart" water heater will disregard the "off" request and the bottom element will turn back on to maintain a large volume of hot water for your use.



- At times when solar or wind energy is produced in excess quantities the utility will request the cold water at the bottom of the tank to be heated
- If neither wind or solar is available, the utility will heat the cold water when cheapest energy is available
- Heat pump water heaters have a more complex method of heating water, but the principles of utility control and the impact on your hot water supply will be the same.



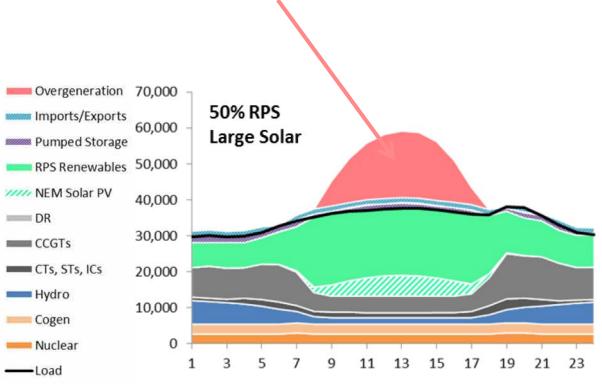
High RPS Means

Overgeneration

 Solar & Wind produce energy in limited hours



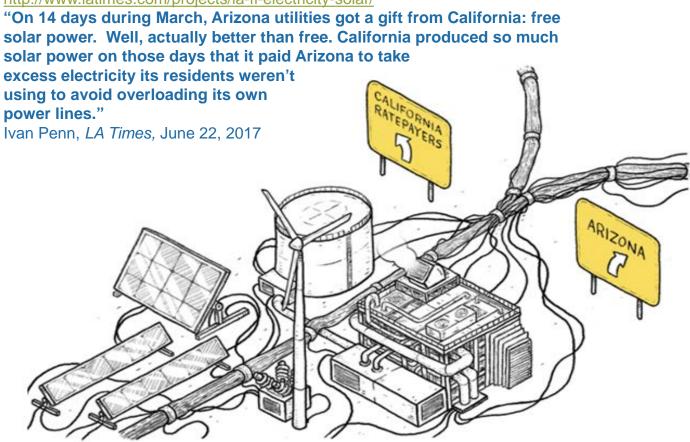
Energy with no place to go!



Reference: Investigating a Higher Renewables Portfolio Standard [RPS] in California, Energy and Environmental Economics, Inc., 101 Montgomery St. San Francisco, CA 94104. Jan 2014

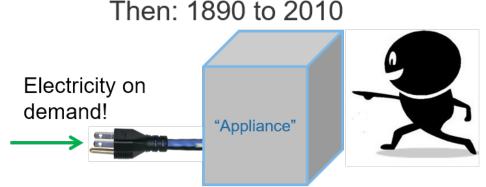
The Optics of Excess Solar

http://www.latimes.com/projects/la-fi-electricity-solar/

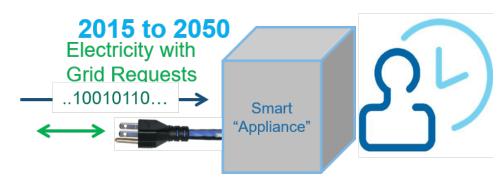


New Concept

- For first 120 years
 - Energy flows one way to customer
 - Customer loads and generation serve best interests of customer
- By 2008, renewables at scale everyone talks about storage
- By 2010, Idea: many loads can respond to price and control signals to help integrate renewable generation.
- No word describes concept



Customer commands; device gives



Customer inputs flexibility→ device serves customer & grid!

Word for an Emerging Concept

 In 2050 need most loads and distributed generation to be alonetic



- Word created in 2014
- Opposite of alonetic is egonetic which is the behavior of today's devices

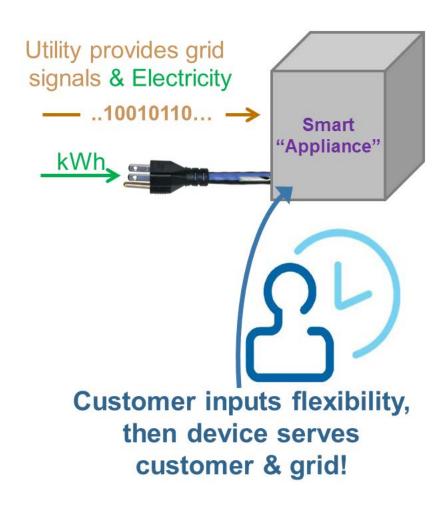
Alonetic, adjective ăl • ō • nět' • ĭk

- alo- from Latin "to support"
- "net" as in the "electric grid network";
- -ic of, or pertaining to

Definition: The ability of an electric device to beneficially support operation of the electric grid

Why Alonetic Devices Create Win-Win

- In a nutshell: Customers benefit because they don't pay full cost of the new technology
- Utility provides "rebates" in return for control permitted by the customer
- Secret sauce in each smart device
 - Manufacturer provides simple way for customer to define flexibility
 - Device receives utility signals via standard communication
 - Control logic in device maximizes grid benefit, but ensures customer needs met



Presentation Highlights: Portland General Electric (PGE)

- Smart water heaters are "reservoirs of energy" that can reduce peak demand and facilitate energy shifting when used in demand response (DR) projects.
 - PGE's DR pilot in collaboration with Bonneville Power Administration (BPA) aims to demonstrate the value of grid integrated water heaters in Pacific Northwest.
 - The pilot uses the Standard Socket (CTA-2045), a low-cost communication technology that receives the utility's signals. The socket is not embedded in the appliance, which protects customers against any potential data threats and makes the connection secure.
 - The pilot has a two-way "hybrid" communication technology to collect research data, i.e. FM broadcasting and WIFI. This allows people to opt out of the twoway communication and still be able to participate in the DR program with FM broadcast only, without sharing their data.
- Greater adoption of smart water heaters will enable more DR capabilities and provide more support for the electric grid.
- Smart water heaters could mitigate the cost of renewable integration: As renewable energy is steadily increasing, integrating intermittent resources can be challenging for utilities. DR programs allow utilities to store energy in water heaters when demand is low to reduce impact on the grid during high demand periods.





Best Practices: Renew Financial

Jonathan Kevles, Vice President of Government Relations





Who is Renew Financial and What is PACE

- Founder and CEO Cisco DeVries first to develop and implement the PACE financing concept
- Renew Financial operates PACE programs in ~90% of CA and ~40% of FL (and growing)
- PACE: Property Assessed Clean Energy.
 - 100% upfront financing for EE, RE, Water Conservation (CA), Seismic (CA), Wind/Hurricane Resistance (FL)
 - Repayment appears as a new line-item on participating property owner's property tax bill
 - Program administration and project funding both 100% privately financed
 - Over >150,000 homes financed across the PACE industry nationally
 - Fixed interest rate, fully amortizing financing
 - Interest rates from 2.49% to 8.49%
 - Rates based on selected repayment term not on FICO, project size, HH income



Estimating the Impacts of the Water-Energy Nexus

- Energy Savings from Water Conservation
 - At the property
 - In the water system

Table ES-1. Recommended revised water-energy proxies

	Indoo	r Uses	Outdoor Uses		
	Northern California	Southern California	Northern California	Southern California	
	kWh/MG	kWh/MG	kWh/MG	kWh/MG	
Water Supply and Conveyance	2,117	9,727	2,117	9,727	
Water Treatment	111	111	111	111	
Water Distribution	1,272	1,272	1,272	1,272	
Wastewater Treatment	1,911	1,911	0	0	
Regional Total	5,411	13,022	3,500	11,111	

http://www.energy.ca.gov/2006publications/CEC-500-2006-118/CEC-500-2006-118.PDF



Estimating the Impacts of the Water-Energy Nexus

Water Savings from Reduced Demand from the Electric Grid

Table 1. 2011 water consumption and withdrawal rates or intensities for the Texas power plant fleet. Note the main control on withdrawal rates is the cooling system (once-through about an order of magnitude higher than tower) (e.g. 138 NGCC, OT versus 1.02 NGCC, T) and main control on consumption is generator with about a factor of three difference between combined cycle and steam turbine plants (e.g. 0.71 NGST, T versus 0.22 NGCC, T). (Note: NG: natural gas, ST: steam turbine, CC: combined cycle, OT: once-through, T: tower.)

Fuel	Generator		Consu	Consumption		Withdrawal	
		Cooling	(gal kWh ⁻¹)	$(L kWh^{-1})$	(gal kWh ⁻¹)	$(L kWh^{-1})$	
Nuclear	ST	OT	0.46	1.74	37.1	140	
Coal	ST	OT	0.54	2.04	36.6	139	
		T	0.65	2.46	0.76	2.88	
NG ST CC	ST	ОТ	0.44	1.67	124	469	
		T	0.71	2.69	0.75	2.84	
	CC	OT	0.18	0.68	36.4	138	
		T	0.22	0.83	0.27	1.02	
Alla	ST, CC	OT, T	0.41	1.55	22.0	83.3	
All ^b	All ^b	All ^b	0.35	1.32	18.8	71.1	

^a Nuclear, coal, and natural gas (371 TWh generation).

http://iopscience.iop.org/article/10.1088/1748-9326/8/4/045033/pdf;jsessionid=AF92A806AECBF2177818117ADC67B419.ip-10-40-2-120



^b Statewide power plant fleet rates, including all fuel, generator, cooled, and non-cooled types (434 TWh generation).

Please contact Jonathan Kevles (Renew Financial) if you have suggestions or studies on methodologies to quantify energy savings from water conservation, or State-level information on the energy-water nexus.

Jonathan Kevles, Vice President - Government Affairs and Market Development

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Presentation Highlights: Renew Financial

- Energy consumption for U.S. water systems can vary depending on region and climate.
 - Overall California's (CA) water system is energy-intensive: ~20% of electric consumption goes toward water-related uses. Southern CA consumes even more energy due to water imported from the Northern region.
 - Use of natural gas for power generation in Texas enhances drought resilience and reduces water demand.
- Water conservation projects are relatively inexpensive due to the low cost of water.
 - PACE program supports water conservation projects in CA; however, few projects meet the minimum threshold of \$5,000 for PACE financing. Most PACE financing used for water projects goes to outdoor projects as indoor projects tend to be less expensive.
- CA regions that experienced drought seem to be more aware of their water consumption and more inclined to use water efficiently.





Discussion Highlights: What are the gaps in knowledge for this topic that, if filled, would help improve work in this area?

- Having a clearer picture of how energy consumption and water use are linked across the U.S. can help programs take more effective actions to target both efficiency and conservation.
 - Renew Financial is working on better quantifying the energy savings that result from water conservations. The organization is collecting state-specific information related to this accounting.
- Increasing awareness around water conservation.
- Encouraging the use of grey water, particularly in commercial and industrial applications, where relevant (e.g. irrigations).
 - Increase awareness of grey water uses and provide incentives for converting systems to grey water where applicable.
- The low cost of water continues to be a barrier to justifying water conservation programs.





Additional Resources

- For more information on California's PACE programs, that cover financing for both energy efficiency and water conservation measures:
 - FACT SHEET ON CALIFORNIA SB 242 & AB 1284 A
 Comprehensive Consumer Protection, Underwriting, and
 Regulatory Framework for Property Assessed Clean Energy
 - PACENation Property Assessed Clean Energy website





Upcoming Seasonal Messaging Opportunities

Now is the time to start planning energy efficiency messaging!

February 2, 2018 Groundhog Day

February 14
Valentine's
Day

February
Super Bowl



Mass Save
Article: Avoid the Shadow
this Groundhog Day



American Home Shield
Article & Card: Valentine's
Cards for our Appliances



Energize Delaware
Facebook Post: Don't let energy
leaks sack your next game day.
A #HPwES home energy audit
is the winning play.

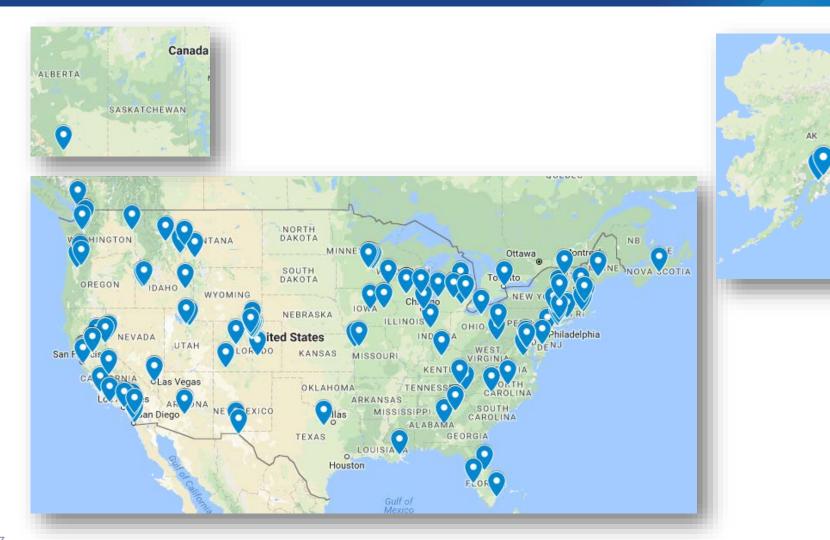




Addenda: Attendee Information and Poll Results



Call Attendee Locations







Call Attendees: Network Members

- AppleBlossom Energy Inc.
- Arlington County Government
- Boulder County
- Center for Energy and Environment
- Center for Sustainable Energy
- City of Providence
- CLEAResult
- Elevate Energy
- Efficiency Maine
- GoodCents
- Habitat for Humanity of Michigan

- International Center for Appropriate and Sustainable Technology (ICAST)
- katsujinken foundation
- Montgomery County
 Department of Environmental
 Protection
- National Association of State Energy Officials (NASEO)
- Park City Municipal Corporation
- Southface
- TRC Energy Services
- Wisconsin Energy Conservation Corporation (WECC)





Call Attendees: Non-Members (1 of 3)

- Alternative Energy Systems Consulting, Inc (AESC)
- Alliant Energy
- Aquanta Inc.
- Cadmus Group Inc.
- CenterPoint Energy
- City of Fullerton
- City of Longmont
- Clark County
- Cleveland State
- Community Office for Resource Efficiency (CORE)
- Idaho Division of Building Safety

- DNV GL
- Energy Efficiency Business Coalition
- Energy Outreach Colorado
- University of North Carolina at Chapel Hill - Environmental Finance Center
- Franklin Energy
- Green Compass Sustainability
- ICF
- Iowa Energy Center
- Lantern Energy
- LEENA Labs





Call Attendees: Non-Members (2 of 3)

- Local Government Commission
- Lockheed Martin Energy
- Minnesota Department of Commerce
- University of Tennessee -Great Smoky Mountains Regional Project
- New Ecology
- Oakland Livingston Human Service Agency
- Plumbing Manufacturers International (PMI)
- Portland General Electric

- Renew Financial
- Residential Energy Services Network (RESNET)
- Red Rocks Community
 College Colorado Community
 College System
- Sarasota County
- Sierra Business Council
- Snohomish County
- Southwest Energy Efficiency Project
- The South-Central Partnership for Energy Efficiency as a Resource (SPEER)





Call Attendees: Non-Members (3 of 3)

- The Association for Energy Affordability, Inc
- Third Rail Technologies
- Treeline Strategy, LLC
- TRJ Construction Inc.
- Utah Governor's Office of Energy Development
- Wells Fargo Home Mortgage





Opening Poll #1

- Which best describes your organization's experience with the energy-water nexus?
 - Some experience/familiarity **50%**
 - Limited experience/familiarity 25%
 - Very experienced/familiar 22.5%
 - No experience/familiarity 2.5%
 - Not applicable 0%





Closing Poll

- After today's call, what will you do?
 - Seek out additional information on one or more of the ideas
 79%
 - Consider implementing one or more of the ideas discussed
 9%
 - Other (please explain) 8%
 - Make no changes to your current approach 4%



